# THE HARVEIAN ORATION

1882.

GEORGE JOHNSON

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# HARVEIAN ORATION

DELIVERED AT THE

## Royal College of Physicians

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BY

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TO

SIR WILLIAM JENNER, BART., K.C.B.

M.D. LOND., D.C.L. OXON., LL.D. CANTAB., F.R.S.

PHYSICIAN IN ORDINARY TO H. M. THE QUEEN

PRESIDENT OF THE ROYAL COLLEGE OF PHYSICIANS OF LONDON

ETC.

THIS ORATION

GIVEN BY HIS DESIRE

IS DEDICATED

WITH SINCERE RESPECT

# THE HARVEIAN ORATION.

## 1882.

Mr. President and Gentlemen,—After accepting the invitation with which you, Sir, honoured me, to undertake the arduous and responsible duty of Harveian orator, my first intention was to take as the main subject of my address the additions to our knowledge of the vascular system, with its nerve supply, which have been made within the last thirty years, and thus to continue the history of these interesting discoveries from the point at which, for want of time, it was left by Dr. Sanderson in the learned oration which he delivered here four years ago. On further consideration, however, it appeared to me that my attention should, by preference, be directed to the systematic attempts which have recently been made in Italy to rob our illustrious Harvey of the honour which

for two centuries and a half has by almost universal consent been conceded to him, and to claim for the Italian Cesalpino (Latin, Cæsalpinus) the credit of having anticipated Harvey in the discovery and demonstration of the circulation of the blood. These attempts to exalt Cesalpino at the expense of Harvey have been referred to and refuted by the late Dr. R. Willis, in his admirable volume entitled 'William Harvey' (London, 1878). But the subject is so important and so full of interest for this college that it may well occupy all the time at my disposal to-day.

It will be remembered that Dr. Sieveking, in his interesting oration delivered in 1877, referred to the fact that a monument in honour of Cesalpino had recently been unveiled in Rome. I am indebted to the kindness of Dr. Pantaleoni, the eminent Roman physician and senator, for a copy of the two orations[1] which, at the inauguration of that monument, were delivered in the presence of a large assembly of learned professors and other eminent and representative men of Italy. The orators were Professors Scalzi and

[1] Inaugurazione della lapide ad Andrea Cesalpino; due discorsi letti in questa occasione dai Prof. F. Scalzi e C. Maggiorani. Roma, 1876.

Maggiorani. The former spoke of Cesalpino as an eminent anatomist, botanist, and mineralogist; while the latter referred to him as a distinguished philosopher. Both these learned professors in the course of their addresses mentioned in terms of praise a work by Dr. Ceradini,[1] professor of physiology in the University of Genoa, the second edition of which had been recently published.

In this volume of three hundred royal octavo pages the author professes to give a true history of the discovery of the circulation of the blood. Professor Scalzi declares this work to be a 'publication of the highest interest for physiological science and the history of medicine;'[2] and Professor Maggiorani,[3] at the conclusion of his address, expresses gratitude to 'Professor Ceradini, who on this festive occasion has presented to

[1] La Scoperta della Circolazione, del sangue, del Dott. G. Ceradini, Prof. di Fisiologia all' Università di Genova. Milano, 1876.

[2] 'Pubblicazione di sommo interesse per la scienza fisiologica, e per la storia della Medicina' (p. 23, note).

[3] 'Giustizia vuole che in tal momento si esprime un senso di riconoscenza al Prof. Giulio Ceradini che si fece occasione di questa festa col dono fatto alla nostra Accademia del suo dotto volume, ove quel che dianzi non era stata che voce più o meno accreditata intorno alla scoperta di Cesalpino, divenne per i nuovi argomenti una dimostrazione scientifica' (p. 62).

the Academy his learned volume, wherein that which heretofore had been only more or less a belief as to Cesalpino's discovery, has become, by means of new arguments, a scientific demonstration.' Professor Ceradini's volume therefore is a work of authority and influence—at any rate among his fellow-countrymen—and as such I have deemed it worthy of a careful study and analysis, with results which I will presently endeavour to set before you. A critical examination of this imposing volume is rendered more necessary by the fact that Cesalpino's published writings being very scarce, and to be found only in large libraries, Dr. Ceradini's version of their physiological teaching will be accepted as trustworthy by all who have not both the opportunity and the inclination to compare his statements with the original treatises.

In the preface to his book Dr. Ceradini suggests, with an evident feeling of satisfaction, that the determination of the Royal Medical Academy of Rome to place within the walls of the University an engraved tablet declaring Cesalpino to be the discoverer of the circulation of the blood, may have been influenced by the

more complete demonstration of Cesalpino's claims which he had been able to give in the first edition of his historical treatise.

I now proceed to quote, as fully as time permits, the chief statements and arguments upon which Dr. Ceradini relies to establish his position that the Italian Cesalpino was, and that our English Harvey was not, the actual discoverer of the circulation of the blood, and I will endeavour to estimate at its true value the judgment of Harvey's critic and accuser. Dr. Ceradini's statement with regard to Harvey is to this effect—that during the four years from 1598 to 1602, which Harvey spent as a student at Padua, he must have become acquainted with Cesalpino's writings,[1] some of which had been published about thirty years before; that in these writings Harvey must have seen that the true doctrine of the circulation of the blood was clearly set forth and completely demonstrated; that Harvey designedly delayed the publication of his work 'De Motu Cordis et Sanguinis' until 1628, twenty-five years after the death of Cesalpino, and nine years after the death of Fabricius, when his ad-

[1] Ceradini, p. 171, &c.

versaries could adduce no proof that his affected ignorance of the discovery of Cesalpino was a mere pretence (p. 172). Ceradini quotes the well-known passage in which Harvey expresses his fear lest, through the novelty of his discovery, he should have all mankind for his enemies (Coll. ed., p. 47; Dr. Willis's trans., p. 45); and on this he makes the following comment: 'Without doubt by these subterfuges the Englishman designed to usurp for himself the glory of a discoverer.'[1]

Harvey's hostile critic asserts that his doctrine of the general circulation was based almost exclusively on the presence of valves in the veins (p. 275), which had been first discovered, or at any rate more fully demonstrated and described, by Harvey's anatomical master, Fabricius; and Ceradini affirms that this evidence in support of the doctrine of the circulation is all that Harvey

[1] 'Nessun dubio che con questi sotterfugi l'Inglese mirasse ad usurpare il vanto di scopritore' (p. 175).

It is interesting to note that Harvey's fears were not without reason. 'John Aubrey tells us he had heard him (Harvey) say that after his book on the "circulation of the blood" came out, he fell mightily in his practice; 'twas believed by the vulgar that he was crack-brained, and all the physitians were against him.'—Dr. R. Willis's *William Harvey*, p. 165.

could add to Cesalpino's prior and complete demonstration. Referring to the Life of Harvey prefixed to the Latin edition of his works which was published by the Royal College of Physicians in 1766, Dr. Ceradini says: 'It lacked the foundation of truth, and therefore, notwithstanding the efforts of the biographer and of his natural allies, the whole College of Physicians, the defence of Harvey was so void of reason, so audaciously partial, so utterly valueless.'[1]

The author admits with regret that some eminent physiologists had pronounced in favour of the claims of Harvey to be the real discoverer of the circulation of the blood; but this erroneous verdict he attributes either to ignorance or to bad faith. In particular he declares his belief that the illustrious Haller[2] and two of

[1] 'Mancava però al biografo il fondamento della verità, ed ecco perchè malgrado gli sforzi suoi e quelli dei naturali suoi alleati, i colleghi tutti del Collegio Medico di Londra, la difesa di Harvey riesciva così vuota di ragioni, così sfacciatamente parziale, così nulla' (p. 278).

[2] Haller's judgment was as follows: 'Adparet non Cæsalpino, ob paucas aliquas et obscuri sensus voces sed Harveio, numerosissimorum experimentorum laborioso auctori, gravique scriptori argumentorum omnium quæ ex ævo proferri poterant immortalem gloriam inventi circuitus sanguinis deberi.'—*Elementa Physiologiæ*, vol. i. L. III. sect. 3, § 32.

Upon this Dr. Ceradini remarks: 'Singolare giudizio davvero!

Cesalpino's own countrymen, Malpighi and Baglivi (p. 205), had their judgments perverted by the embarrassing fact that they had been elected Fellows of the Royal Society of London.

Ceradini allows, as an excuse for Harvey's pretensions, that, inasmuch as he had contributed somewhat to the complete demonstration of his predecessor's doctrine, and had undergone great labour in his endeavour to make it known and to overcome the infinite prejudices by which it was opposed, he may at length have persuaded himself that Cesalpino's discovery was actually his own. But he proceeds to say that these considerations, while they in part justify Harvey's conduct, avail not to excuse that of his fellow-countrymen, who to this day, in spite of truth and justice, believe, or feign to believe, him to be the discoverer of the circulation of the blood —perhaps, he sarcastically adds, in order not to deprive themselves of the pretext for an annual celebration of his memory *inter pocula*.[1]

ma che sarebbe anche più singolare, se Haller non si fosse trovato nella stessa difficile condizione di Malpighi e Baglivi, nella condizione cioè di membro della Reale Accademia di Londra' (p. 266).

[1] 'Ma queste considerazioni, se giustificano in parte la condotta di Harvey, non valgono affatto di scusa a quella de' suoi connazionali, i

I will venture to say that if Dr. Ceradini had been a contemporary of Harvey he would have received from the object of his attack no other notice than that contained in the following sentence: 'Detractors, censurers (momos), and writers defiled with abuse, as I have resolved with myself never to read them, satisfied that nothing solid or excellent, nothing but malediction was to be expected from them, so have I held them still less worthy of an answer' (Coll. ed., p. 109; Dr. Willis's trans., p. 109).

In my endeavour to refute these monstrous charges against the greatest ornament of our College, and one of the greatest benefactors of the human race, I shall make no attempt to emulate the quite inimitable good taste and style of the Genoese Professor; but I shall endeavour, and I trust successfully, to show that, however diligent may have been Harvey's study of Cesalpino's writings, he could never have obtained from them that which is not to be found therein, viz., a knowledge of the circulation of the blood; and

quali oggi ancora a dispetto della verità e della giustizia lo ritengono, o fingono ritenerlo scopritore della circulazione del sangue, forse, per non privarsi, come argutamente osservava Barzelotti, del pretesto di festeggiarne la memoria *inter pocula*' (pp. 298–9).

that those who pretend to find in these writings the true doctrine of the circulation, endeavour to establish their position by giving to some chance expressions a meaning which the context shows could never have been in the mind of their author; while interpreting Cesalpino's vague and contradictory statements by the light of Harvey's researches, they ungratefully turn upon the real discoverer and accuse him of conscious plagiarism. This surely is very like an attempt to pierce the breast of an eagle with an arrow feathered by a plume plucked from his own wing.

If Cesalpino's discovery and demonstration of the course of the blood were so complete and unmistakable as his recent advocates maintain, it is remarkable that his contemporaries and immediate successors, to whom his writings must have been well known, should have remained in ignorance of the true doctrine of the circulation. Professor Scalzi, indeed, in his inaugural address, suggests that Harvey may have learnt the new doctrine of Cesalpino from his famous anatomical teacher Fabricius;[1] but, unfortunately for this

[1] 'Fu gran ventura per Guglielmo Harvey, che trovandosi dal 1598 al 1602 in Padova allo studio della medicina, potesse

suggestion, the work of Fabricius ('De Venarum Ostiolis'), which was published in 1603, a year after Harvey's departure from Padua, and rather more than thirty years after the publication of Cesalpino's chief treatise ('Quæstionum Peripateticarum libri quinque,' Florent. 1571), affords conclusive evidence of its author's entire ignorance of the circulation of the blood through the systemic vessels.

Fabricius believed that the purpose of the valves in the veins was not to favour the passage of blood to the heart, but to prevent over-distension of the veins by the blood in its passage through the venous trunks to their branches, and also to retard the current of blood, so that time might be given for each part to take up its proper nutriment; and he states that valves are not required in the arteries, because, on account of the thickness and strength of their coats, they are not liable to be over-distended. Neither are valves required to retard the stream of blood, because in the arteries there is a perpetual flux and reflux

apprendere la dottrina novella da Fabrizio d'Acquapendente, al quale il grido di anatomico sommo chiamava scolari anche da oltralpe,' pp. 18, 19.

of blood.[1] This, then, was the doctrine of the systemic circulation held and taught by the most eminent anatomist of Italy thirty years after the publication of Cesalpino's supposed discovery.

Professor Ceradini even admits that Fabricius had not the most remote idea of a circulation of the blood.[2] Upon this Dr. Willis pertinently asks: 'If this be true, who among his contemporaries could be better informed?' If Cesalpino had given an intelligible account of the circulation through the systemic vessels, his fellow-countryman Fabricius, of all men, would have been the least likely to be ignorant of it, and his ignorance may be taken as a fair index of the knowledge of his contemporaries.

Now, in order to correctly estimate Cesalpino's claims as an original observer, and to understand

[1] 'Erat profecto necessaria ostiolorum constructio in artuum-venis, ut scilicet sanguis ubique eatenus retardaretur, quatenus cuique particulæ alimento fruendi congruum tempus detur. Arteriis autem hæc ostiola non fuere necessaria; neque ad distensionem propter tunicæ crassitiem ac robur, neque ad sanguinem remorandum, quod sanguinis fluxus refluxusque in arteriis perpetuo fiat.'—Fabricius 'De venarum ostiolis,' p. 2.

[2] 'È notissimo del resto che Fabricio non ebbe la più lontana idea di una circulazione del sangue.'—Ceradini, p. 148.

some of the terms which he employs, we have to consider to what extent a knowledge of the circulation had been obtained by his predecessors.

From the time of Galen, in the second century of the Christian era, to that of Servetus, in the sixteenth century, it was supposed that the blood, passing from the vena cava into the right side of the heart, was there divided into two streams, which took different courses. While a part of the blood passed by invisible pores through the septum from the right to the left side of the heart, the other portion was sent by the pulmonary artery (vena arterialis) to nourish the lungs. But as all the blood thus sent to the lungs was not required for their nutrition, a certain portion passed into the pulmonary vein (arteria venalis) by means of a supposed anastomosis between the two vessels, and so reached the left side of the heart. The Spaniard Michaelis Servetus made an advance upon Galen's physiology of the pulmonary circulation in this respect, that he maintained that the blood passes from the right to the left side of the heart, not at all by invisible pores in the septum, but entirely by free communication between the pulmonary artery (vena

arterialis) and the pulmonary vein (arteria venalis), the dark blood from the right side of the heart assuming a crimson colour in its passage through the lungs.[1]

The Italian Realdus Columbus, who succeeded Vesalius as Professor of Anatomy at Padua, and who died at Rome in 1577, published his work 'De Re Anatomicâ' six years after the publication of the 'Christianismi Restitutio' of Servetus.

In this book Columbus claims to have been the first to describe the passage of the blood from the right to the left side of the heart by the pulmonary vessels. It is certain that in the date of publication Servetus had anticipated him by six years; but it is possible that the writings of Servetus, which, together with their author, were burnt at the stake at the instigation of Calvin, may not have been known to Columbus. Professor Ceradini suggests (p. 99)—but so far as I can see without adducing any evidence in support of his conjecture—that Servetus may have been a

[1] 'Fit autem communicatio hæc non per parietem cordis medium, ut vulgò creditur. Sed magno artificio à dextro cordis ventriculo, longo per pulmones ductu, agitatur sanguis subtilis: à pulmonibus præparatur, flavus efficitur, et à venâ arteriosâ in arteriam venosam transfunditur.—*Christianismi Restitutio*, 1553, p. 169.

pupil of Columbus at Padua, and may there have learnt from his anatomical teacher the doctrine which he afterwards published as his own.

What was known then and taught with regard to the circulation before the publication of Cesalpino's writings was briefly this—that the blood from the vena cava enters the right side of the heart, and thence passes through the lungs to the left side, whence it is distributed by the aorta over the whole body. What we now call the pulmonary circulation, therefore, was fairly well understood. With regard to the systemic circulation, however, nothing definite was known. It was supposed that while the veins conveyed one kind of blood called *auctive* blood to the tissues, the arteries supplied them with *nutritive* blood of a more spirituous nature; that there were communications between the arteries and veins by invisible inosculations or anastomoses, as the result of which auctive blood passed into the arteries, which in their turn gave back spirituous blood to the veins. By these anastomoses Galen explained the fact that the wound of a large artery empties not only the arteries but the veins. The movement of blood in the vessels, both arte-

ries and veins, was supposed to be of a to-and-fro character. From the time of Aristotle to that of Cesalpino, and, as we shall presently see, by Cesalpino himself, this movement was compared to the tides of Euripus—that is, to the ebb and flow of the tide in a narrow channel. This, then, was the state of knowledge, or rather of ignorance, with regard to the movement of blood in the systemic vessels before the publication of Cesalpino's writings. We have now to inquire to what extent he succeeded in throwing light upon the subject.

With regard to the structure of the heart and its valves, Cesalpino says that it is so arranged as to allow of continuous motion from the veins to the heart, and from the heart to the arteries.[1] In these statements there was nothing new. In the chapter 'De Pulmonis Constitutione' he says[2] 'the

[1] 'Ut continuus quidam motus fieret ex venis in cor et ex corde in arterias.'—*Speculum Artis Medicæ*, lib. vi. cap. xix., ed. 1670, p. 473.

[2] 'Fertur igitur ex corde sanguis fervidus per arteriam ex dextro ventriculo, quam Galen venam arterialem vocat, in pulmonem iterumque cordi redditur per venam ex sinistro ventriculo prodeuntem, quam Galen arteriam venalem vocat. Interim in itinere contemperatur ab aere frigido inspirato in asperas arterias juxta venas et arterias, ut circulatione quadam sanguis perficiatur in naturam spiritus, prius in dextro ventriculo deinde in sinistro.

hot blood is carried from the right ventricle by the artery which Galen calls the vena arterialis into the lung, and is again conveyed to the heart by the vein proceeding from the left ventricle which Galen calls the arteria venalis. Meanwhile in its passage the blood is tempered by the cold air inspired into the branches of the windpipe which lie near the veins and arteries, so that by a kind of circulation the blood is converted into the nature of spirit, first in the right ventricle, then in the left. Therefore the vessel leading from the right side of the heart is a true artery, having a double tunic, in order that the spirits should not escape from it; the vessel entering the left side of the heart is a vein consisting of a single tunic, because it contains blood which has been already refrigerated in the lung.'

Cesalpino's second reference to the circulation through the lungs occurs in his treatise ('Quæstionum Peripateticarum libri quinque,' lib. v. p. 125 D, ed. 1593) in the following terms:—[1]

Ideo vas educens è corde vera arteria est ex duplici tunicâ, ut spiritus non evanescant; vas introducens vena est ex unica tunica constans, quia sanguinem jam refrigeratum continet.'—*Spec. Art. Med.*, lib. vi. cap. ix. p. 443.

[1] 'Idcirco pulmo per venam arteriis similem ex dextro cordis ventriculo fervidum hauriens sanguinem, eumque per anastomosim

'Thus the lung, drawing warm blood from the right ventricle of the heart through the vein which resembles an artery (pulmonary artery), and sending it by anastomosis to the arteria venalis (pulmonary vein), which enters the left ventricle of the heart, tempers it meanwhile by the cold air which is conducted into the branches of the windpipe which lie near the arteria venalis, and this, not by inosculation between the blood-vessels and the air-tubes, as Galen supposes, but by contact alone. With this circulation of the blood from the right ventricle of the heart through the lungs to the left ventricle the appearances on dissection exactly correspond, for there are two vessels connected with the right ventricle and two with the left; but of the two vessels one only intromits, while the other emits, the valves being constructed with that design.' He then refers to the errors of his predecessors in

arteriæ venali reddens, quæ in sinistrum cordis ventriculum tendit, transmisso interim aere frigido per asperæ arteriæ canales, qui juxta arteriam venalem protenduntur, non tamen osculis communicantes, ut putavit Galen, solo tactu temperat. Huic sanguinis circulationi ex dextro cordis ventriculo per pulmones in sinistrum ejusdem ventriculum optime respondent ea quæ in dissectione apparent. Nam duo sunt vasa in dextrum ventriculum desinentia, duo etiam in sinistrum. Duorum autem unum intromittit tantum, alterum educit, membranis eo ingenio constitutis.'

calling all the blood-vessels connected with the right side of the heart veins, while those on the left side are designated arteries, and he says that the vessel on the right side which had hitherto been called vena arterialis has the structure of an artery, and pulsates in consequence of receiving blood from the heart, while the vessel on the left side, called arteria venalis, has the structure of the other veins, and does not pulsate, because it only conveys blood to the heart.'[1] 'All things, therefore, are admirably fashioned, for since it was necessary that the blood should be brought to the heart in order that it might become perfect nutriment—first in the right ventricle, in which a thicker blood is contained, and then in the left, which has a purer blood—it is transmitted from the right to the left ventricle, partly through the septum, partly, for the sake of being refrigerated, through the lungs' (note *a*).[2]

[1] The pulsation of the pulmonary artery was known to Galen: 'Neque te fugiet vas illud quod cordi connectitur, a cava vena progerminatum, etiam ipsum quemadmodum arteriæ pulsare'—*Galen de utilitate respirationis* (c. 4). The probable reason why the ancient anatomists called the pulmonary artery a vein, and the vein an artery, is that the former is usually found more or less distended with blood after death, while the latter, being often found empty, was believed to contain only air.

[2] 'Partim per medium septum partim per medios pulmones,

From the preceding extracts it appears that Cesalpino's account of the pulmonary circulation is identical with that given by his predecessors, Servetus and Columbus, except that in one sentence (being apparently still under the influence of Aristotle and Galen) he speaks of the passage of blood from the right to the left side of the heart as taking place partly through the septum. Dr. Ceradini argues that, since Cesalpino refers to the permeability of the septum cordis only once in one of his works, he did this rather in deference to his admired master Aristotle, and not from a firm belief in the doctrine. But surely a disciple who quotes his master's doctrine without expressing dissent must be held to accept and agree with it. Cesalpino, being ignorant of the real function of the heart and arteries, thought that the purpose of the thick pulmonary artery was to prevent the escape of the spirits, while the thin pulmonary vein sufficed to hold the blood which, as he erroneously supposed, had been cooled by passing through the lungs.

It is a fact that the word *circulation* is here for

refrigerationis gratia, ex dextro in sinistrum transmittitur.'—*Quæst. Per.*, p. 126 *A*.

the first time used to describe the movement of the blood from the right to the left side of the heart. Cesalpino's fellow-countrymen make much of this word, and argue as if it implied a knowledge, not only of the pulmonary, but also of the systemic circulation; but it is a noteworthy and most significant fact that this term is employed by Cesalpino only with reference to the passage of the blood through the lungs, and never in his attempt to explain the movement of the blood in the systemic vessels. This restriction of the word circulation to the pulmonary part of the circuit is *pro tanto* evidence that he was ignorant of there being a continuous passage of blood from the systemic arteries to the veins, identical with that which had been found to occur through the pulmonary vessels, and to which the term *circulation* is equally applicable (note *b*).

Yet to anyone who reads Dr. Ceradini's account of Cesalpino's doctrine of the general circulation without reference to the original publications, it would seem obvious that the Italian physiologist had completely demonstrated the perpetual passage of the blood from the aorta through the capillaries to the veins, from the veins to the

right side of the heart, and thence again through the lungs to the left side of the heart; but a careful comparison of the Professor's free translation of Cesalpino's language with the original text, and a comparison of Cesalpino's confused and contradictory statements with each other, will lead any unbiassed critic to a very different conclusion.

The word *capillamenta* is occasionally used by Cesalpino, and this his modern interpreters invariably translate by the term 'capillaries.'[1] Dr. Ceradini in fact maintains that so complete were Cesalpino's proofs of the systemic circulation, that Malpighi's microscopical demonstration of the capillary vessels could add nothing to the certainty of his doctrine (p. 295).

Professor Scalzi also in his address[2] credits Cesalpino with a complete knowledge of the capillary circulation, and laments that Harvey, having misunderstood his Italian predecessor's teaching, wandered from the track which had

[1] 'Cesalpino aveva detto che il sangue porta d'apprima l'alimento nutritivo alle parti, poi l'alimento aumentivo al cuore dopo essere passato dalle arterie nelle vene pei capillari sparsi in tutti gli organi.'—*Ceradini*, p. 177.

[2] 'Egli dunque conobbe la circolazione capillare che doveva poi farsi più solennemente manifesta da Marcello Malpighi, altro genio d'Italia,' p. 22.

been so splendidly marked out by Cesalpino, and substituted for the Italian's demonstrated capillaries his own theory of 'porosities in the tissues,' through which the blood was supposed to pass from the arteries to the veins (note *c*).

Now, surely to credit Cesalpino with having acquired a knowledge of the capillary vessels without the aid of the microscope, is to suppose him to have been endowed with superhuman sagacity. Obviously it was as impossible to form a conception of the capillary circulation until the microscope had rendered the minute vessels visible as it was to discover Jupiter's moons or Saturn's rings before the invention of the telescope. And if we refer to the passages in which Cesalpino introduces the word capillamenta, we shall see that if, as is probable enough, Harvey was acquainted with his predecessor's writings, he could have derived from them no assistance in his attempt to trace the course of the blood from the arteries to the veins.

I now proceed to give some extracts having reference to Cesalpino's use of the word 'capillamenta.' He says: 'The vena cava and the aorta, after entering all the viscera except the heart,

pass beyond them, or if any come to an end, they are resolved into capillamenta (hairlike filaments),[1] and do not pour their blood into a cavity, for nowhere except in the heart is the blood contained in a cavity out of a vein.' He goes on to say that 'the heart is the origin, not only of all the blood-vessels, but also of the nerves, the heart being the centre of the emotions which pass thence to the external parts, whilst sensations pass from the external parts to the heart.'[2]

Cesalpino confirms Aristotle's doctrine that the main function of the brain is to cool the blood contained within it. 'For this purpose,' he says, 'not a few and large, but many small veins from the aorta and the cava are distributed to the brain, which is supplied by blood, not gross and thick, but thin and pure.'[3] The brain then is

[1] 'Vena cava et, arteria aorta reliqua viscera, excepto corde, postquam adierint, transmeant ulterius, aut si quæ desinunt in capillamenta resolvuntur.'—*Quæst. Per.*, lib. v. p. 116 *A*.

[2] 'Cor principium omnium venarum (arteriæ enim sub nomine venarum intelliguntur Aristoteli) ex dictis patet. Sed et nervorum quoque ortum ab eodem duci, hinc manifestum fiet. . . . Sensus enim incipiunt ab exterioribus organis et desinunt in corde,' p. 116 *B*.

[3] 'Propter hoc autem circa cerebrum non paucæ ac magnæ, sed tenues ac frequentes venæ ex cava et aorta sparguntur: neque sanguis copiosus et crassus, sed tenuis sincerusque tendit eodem.'—*Quæst. Perip.* p. 120 *A*.

compared to the condensing apparatus of a spirit still;[1] 'so when the thinnest part of the hot blood of the heart is sublimated, if there were no refrigerating place, the best part of the blood would vanish into the air, and not perform its admirable natural functions. Therefore, as it is the nature of heat to ascend, nature has for the best of reasons placed the cold and moist brain above, and those who have most heat and blood, as man for example, have most brain. But the venules scattered through the brain, if they ceased there and were not carried on into the organs of sense, would be useless, for how could they exhaust the pure and tempered blood?'

'It is[2] therefore necessary that the venules

[1] 'Sic quoque cum ex sanguine in corde fervente tenuissima pars sublimetur, nisi fuisset locus refrigerationis, optima pars sanguinis in auram evanuisset, nec admiranda naturæ opera perfecisset. Optima igitur ratione cerebri substantia frigida et humida in superiori loco a natura condita est, quia caloris natura est sursum ascendere et quæ plurimum habent caloris ac sanguinis iis plurimum quoque cerebri datum est, ut homini. Venulæ autem in cerebrum dispersæ, si inibi desinerent, nec ad organa sensuum ferrentur inutiles fuissent, quomodo enim hæc sanguinem sincerum et temperatum haurient?'—p. 120 *C.*

[2] 'Necesse igitur est continuas esse venulas è cerebro iterum egredientes ad sensuum instrumenta. At nullum aliud corpus è cerebro egredi videmus præter nervos: nervi igitur venulæ illæ fuerint multæ in unum coeuntes non communem canalem, sed corpus ex pluribus canalibus ac tenuissimis compositum: idcirco

should be continued and pass out from the brain to the organs of sense; but nothing is seen to pass out of the brain but the nerves; the nerves, therefore, must be these numerous venules, collected, not into one common canal, but into a body composed of many and most minute canals. Therefore a nerve is divisible lengthways, for the venules terminate in straight fibres constituting the nerves.' This Cesalpino says is Aristotle's doctrine, and he asks: 'What can be more clear than this dictum, for a nerve is nothing more than the extremities of the aorta—some taking the nature of nerves in the head, that is, in the brain; others about the lower parts, that is, in the limbs and joints of the whole body.'[1] . . .

fissilis est nervus secundum longitudinem: nam venulæ in fibras rectas desinunt nervos constituentes'—p. 120 *D.*

[1] 'Quid potest hoc dicto clarius esse? nihil enim aliud est nervus quam extrema aortæ, alia quidem in capite, id est in cerebro naturam nervi accipientia, alia autem circa imas partes, id est circa crura et articulos totius corporis . . . . Sententia igitur est Aristoteles ex aorta ad caput tendente oriri nervos cerebri . . . . Meatus igitur quos scribit Aristoteles ad oculos pervenire ex venulis quæ sunt circa cerebrum, quid aliud sunt quam nervi appellati visorii? Stultum autem est credere non esse meatus, si quis amplum quemdam canalem in ipsis non percipiat. Ut enim capillum perforatum esse scimus, non tamen visui ob parvitatem meatus apparet, sic nervos ex aliis signis fistulosos esse cognoscimus, visui tamen non sunt manifesti meatus'—120 *E. F.*

'It is therefore the opinion of Aristotle that from the branches of the aorta going to the head the nerves of the brain arise. Those passages which Aristotle describes going from the veins about the brain to the eyes, what are they but the nerves of vision? But it is unwise to doubt that there are passages within them, because a large canal is not visible. For as we know that a hair is perforated, although its canal is not visible on account of its minuteness, so by other signs we may perceive the nerves to be tubular, although their canals are not visible.'

Again,[1] the blood-vessels emerge from the skull by certain foramina passing on to the organs of sense, conveying the spirit, and as it were the flower of the blood, rather than actual blood itself.'[2] . . . 'Since the nerves the more they are lengthened the colder they are, because they are more distant from the heart, it was necessary that

[1] 'Hæc (vascula) iterum ex calvaria multa simul per foramnia quædam egressa, ad instrumenta sensuum feruntur, spiritum ac veluti florem sarguinis potius quam sanguinem ferentia,' 120 *F*.

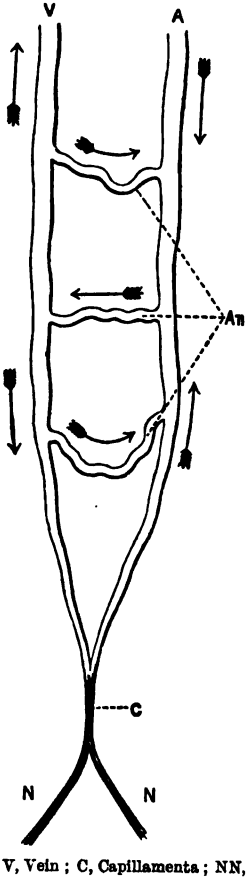
[2] 'Præter eum nervi quanto magis protrahuntur, eo frigidiores sint, quia distantiores a corde fiunt, propter hoc quoque necesse fuit jungi cum arteriis ac venis ut earum calore foverentur; sic enim communicatione facta temperies in carne fit sensui commoda'—p. 131 *A*.

they should be connected with the arteries and the veins, in order that they might be warmed by their heat; for a communication being made, there is effected a tempering of the tissues suitable for sensation.' Lastly,[1] if the spirits are conveyed through the nerves for the purpose of sensation, it does not follow that the sentient part is of a sanguineous nature, for the nerves do not convey blood.'

It is evident from these passages, to which others, consistently expressing the same doctrine, might have been added, that Cesalpino's 'capillamenta,' which his modern Italian commentators, Professors Ceradini and Scalzi, convert into capillary blood-vessels, were the supposed filamentous terminations of arteries and veins in nerves; and that through the tubular nerves the spirituous part of the blood was supposed to pass, and thus to confer a sentient power upon the nerves. But in no single passage of Cesalpino's works, is there to be found any mention of the capillamenta as channels by which the blood passes from the arteries to the veins; and it is particularly stated in

[1] 'Si spiritus per nervos deferuntur ad sensus perficiendos, non erit necesse sanguinem esse quod sensit; nervi enim sanguinem non ferunt.'—*Quæst. Perip.* 130 *F.*

a passage which I have just now quoted, that the nerves which are supposed to intervene between




A, Artery ; V, Vein ; C, Capillamenta ; NN, Nerves ; An, Anastomoses.

the capillamentous termination of the arteries and the veins do not convey blood.

I have endeavoured to represent Cesalpino's description by a diagram. The arrows represent the to-and-fro movement of the blood, alike in the artery, in the vein, and in the anastomoses (note *d*).

In contrast with these capillamentous fictions of Cesalpino I would direct attention for a moment to Harvey's minute dissections of the blood-vessels and the nerves of the human body, which are preserved in the glass cases on the opposite wall of our library. Those interesting memorials of Harvey's industry had long been carefully kept at Burley-on-the-Hill, the seat of the Earls of Winchelsea, one of whose ancestors, the Lord Chancellor Nottingham, had married a niece of Harvey. They were presented to the College in 1823 by the Earl of Winchelsea, who expressed a hope that those specimens of Harvey's scientific research would be deemed worthy of their acceptance.[1] These precious memorials of the great anatomist afford an interesting illustration of a passage in the dedication of the treatise

[1] See *The Roll of the Royal College of Physicians*, by Wm. Munk, M.D., vol. i. p. 144.

'De Motu Cordis et Sanguinis' (Coll. ed., p. 7; Dr. Willis, p. 7). Harvey says: 'I profess both to learn and to teach anatomy, not from books, but from dissections; not from the positions of philosophers, but from the fabric of nature.' It is probable enough that when he penned this sentence he had in his mind the author of the 'Quæstiones Peripateticæ,' and his vain attempts to reconcile Aristotle's philosophy with the facts of anatomy and the marvellous phenomena of living beings.

Evidence of Cesalpino's entire ignorance of a system of capillary blood-vessels is afforded by the fact that when he refers to the communication between the arteries and the veins, he always speaks of this as occurring by inosculations, which the Greeks call anastomosis; thus he says,[1] 'there is a constant movement from the heart through the arteries to all parts of the

[1] 'Motus igitur continuus a corde in omnes corporis partes agitur quia continua est spiritus generatio qui sua amplificatione diffundi celerrime in omnes partes aptus est, simul autem alimentum nutritivum fert et auctivum ex venis elicit per osculorum communionem quam Græci anastomosim vocant: tandem vero spiritu in aerem ambientem difflante alimenti corpulentia remanet, partim frigore partim calore coagulata. Ad difflationem autem spiritus et sanguinis distributionem in partes, vasa residere oportet, donec novus spiritus iterum repleat ac distendat.'—*Quæst. Peripat.* p. 123 *B.*

body, because there is a constant generation of spirit, which by its expansion is ready to be diffused into all parts. At the same time it carries nutritive aliment, and elicits from the veins auctive aliment, by means of the inosculations which the Greeks call anastomosis; but the spirits at length escaping into the ambient air, the bodily part of the aliment remains, being coagulated partly by cold and partly by heat. After the diffusion of the spirit and the distribution of the blood, the vessels remain at rest until a fresh supply of the spirit again fills and distends them' (note *e*).

This passage, while it is quite in accordance with the Galenic doctrine of the veins and arteries containing two kinds of blood, auctive and nutritive, and communicating with each other by anastomosis, is quite inconsistent with the idea of a capillary system of vessels. Some blood, with its auctive nutriment, is supposed to be drawn from the veins into the arteries, and that which is carried beyond the anastomosis is said to be partly evaporated and partly rendered solid; but no reference is made to the passage of any part of the blood from the terminal arteries into the veins.

It will be seen, too, that the diffusion of the blood through the arteries was supposed to be due, not to the propulsive power of the heart, which Harvey was the first to demonstrate, but to the constant generation and expansion of the spirits.

Again, a reference to Cesalpino's description of the supposed cooling influence of the air upon the blood affords collateral evidence, if such were needed, that he had no conception of thin walled capillary blood-vessels, through which the air and the blood exert a mutual influence upon each other. Thus, in describing the relation of the blood-vessels to the air-tubes in the lungs, he remarks that,[1] 'with good reason the branches of the wind-pipe are placed by the side of the pulmonary vein, not by the pulmonary artery;' and he gives the following reason for this: 'For the vein, having a more simple texture and consisting of only one thin tunic, can be more readily

[1] 'Et merito huic vasi (*i.e.* venæ), protenduntur asperiæ arteriæ canales non alteri educenti (*i.e.* arteriæ): nam hoc simplicius existens ex unica eaque tenui tunica constitutum, refrigerari facilius poterat, præterea pulsationi alterius vasis impedimento fuisset asperiæ arteriæ dilatatio et constrictio si juxta essent posita.'—*Quæst. Per.*, 125 *F.*

refrigerated (*i.e.* by contact with the air), and besides, the dilatation and contraction of the air-tubes would have interfered with the pulsation of the artery if they had been placed near together.'

In this passage we have conclusive evidence that the author had no knowledge of minute capillaries through which the blood is exposed to the influence of the air, but on the contrary he supposed this to occur in thin walled veins, of such a size that, if they were arteries, their pulsation would be impeded by the supposed dilatation and contraction of the contiguous air-tubes.

In another passage, the theory that the veins are cooled by being placed near the air-tubes again finds expression. After having shown, as he states, that the brain is a blood refrigerator, he goes on to say:[1] 'For this cause inspiration of air occurs through the nostrils, which terminate near the brain, not only on account of the sense

[1] 'Ob hanc vero causam fit aeris inspiratio per nares juxta cerebrum desinentes, non solum olfactus gratia, sed etiam ut venæ per collum ascendentes ad cerebrum usque, refrigerentur, protenduntur enim juxta asperam arteriam venæ cerebrum petentes.'—*Quaest. Per.*, p. 126 *A*.

of smell, but also in order that the veins ascending from the neck to the brain should be cooled; for the veins passing towards the brain are placed near the wind-pipe.' Here we have expressed not only the theory of blood cooling by the contact of veins with the trachea, but the veins are spoken of as 'ascending through the neck to the brain,' a statement which would never have been made by one who knew that the course of the blood in the veins of the neck is perpetually downwards.

Dr. Ceradini repeatedly asserts that Cesalpino proved and demonstrated the systemic circulation by his observation of the effect of *obstructing the flow of blood through the veins.* And I propose now to examine Cesalpino's statements in connection with Ceradini's comments and conclusions. In the treatise 'Quæstiones Medicæ,' p. 234, Cesalpino says:[1] 'It is worthy of inquiry

[1] 'Sed illud speculatione dignum videtur propter quid ex vinculo intumescunt venæ ultra locum apprehensum, non citra; quod experimento sciant qui venam secant: vinculum enim adhibent citra locum sectionis non ultra; quia venæ tument ultra vinculum non citra. Debuisset autem opposito modo contingere, si motus sanguinis et spiritus a visceribus fit in totum corpus: intercepto enim meatu non ultra datur progressus: tumor igitur venarum citra vinculum debuisset fieri.'—*Quæst. Med.*, p. 234 *A.*

why, when a ligature is applied, the veins swell beyond and not on this side of the obstruction, which those who practise venesection know by experience; but the opposite ought to occur if the motion of the blood and spirit is from the viscera over the entire body; for the passage outward being blocked, a swelling of the veins should occur on this side of the ligature.' Then, after quoting Aristotle's explanation, which is quite unintelligible, he gives his own: 'In explanation of this it is to be observed that the orifices of the heart are so arranged by nature that there is an entrance from the vena cava into the right ventricle, whence there is an open passage into the lungs, and from the lungs there is an entrance into the left ventricle, and thence into the aorta, valves being placed at the orifice of the vessels to prevent reflux. There is thus a perpetual movement from the vena cava through the heart and lungs to the aorta, as we have explained in our peripatetic questions.' Up to this point Cesalpino's description is clear and correct; but it goes not beyond the knowledge of his contemporaries. After this, confusion begins to be appa-

rent.[1] 'As in waking hours the motion of the native heat is outwards, viz., to the organs of sense, but during sleep it is inwards towards the heart, it is to be supposed that during wakefulness much spirit and blood are carried to the arteries, whence there is a passage to the nerves; but during sleep the same heat returns to the heart by the veins, not by the arteries; for the only entrance to the heart is by the vena cava, not by the aorta. The proof of this is to be found in the pulse, which in those who are awake is large, strong, quick, and with a certain vibration,[2] but during sleep it is small, feeble, and slow; for during sleep less native heat goes to the arteries, while it passes into them more forcibly when we are awake. But in the veins the reverse occurs, for they are fuller during sleep and smaller during wakefulness, as may be seen in those of the hand; for during sleep the native

[1] 'Cum autem in vigilia motus caloris nativi fiat extra, scilicet ad sensoria: in somno autem intra, scilicet ad cor; putandum est in vigilia multum spiritus et sanguinis ferri ad arterias, inde enim in nervos est iter. In somno autem eumdem calorem per venas reverti ad cor, non per arterias; ingressus enim naturalis per venam cavam datur in cor non per arteriam. Indicio sunt pulsus, &c.'—*Quæst. Med.* 234 *B.*

[2] This description of the pulse, as Ceradini admits (p. 272, *note*), is literally copied from Galen.

heat passes from the arteries to the veins by inosculations, which are called anastomosis, and then to the heart; but as the outward flow of the blood to the superior parts, and its return to the inferior parts like Euripus, is manifest during sleep and wakefulness, so is this kind of motion in whatever part of the body a ligature is applied, or when in any other way the veins are obstructed, not obscure.[1] For as when the passage is closed rivulets swell up where they are accustomed to flow, so perhaps does the blood at the time return to its source, lest being cut off it should be extinguished' (note *f*).

Cesalpino's statements and arguments may be summed up thus: During wakefulness the blood passes from the aorta to the nerves, as before explained in connection with the word *capillamenta*, while during sleep it passes from the arteries by the before-mentioned anastomoses, not by capillaries, through the veins to the heart. According to this view the swelling of the veins on the distal side of the ligature should occur only during sleep, and the only suggested explanation of its

[1] 'Cum enim tollitur permeatio intumescunt rivuli qua parte fluere solent, forte recurrit eo tempore sanguis ad principium, ne intercisus extinguatur.'—234 *C.*

occurrence at other times is, that perhaps when a vein is obstructed 'the blood returns to its source, lest being cut off it should be extinguished.'[1]

Now, surely if Cesalpino had known that there is a continual flow of blood from the branches of the aorta to the veins, and so back to the heart, he would in a sentence have given the simple and obvious explanation of the fact constantly observed, as he says, by those who practise venesection; but for want of this knowledge he suggests an explanation of the phenomenon which is partly metaphysical and wholly unintelligible.

Dr. Ceradini admits that Cesalpino's expression ('exundatio ad superiora retrocessus ad inferiora') 'outward flow to the superior parts, and return to the inferior parts, like Euripus,' is a comparison borrowed from Aristotle, and therefore it may be assumed not to contain any new doctrine. But he quotes a sentence from Harvey with an attempt to show that it is identical with Cesal-

[1] If Cesalpino had been asked what became of the blood which during the waking state was continually being sent through the arteries, since during sleep only did he suppose it to return by the veins, he would probably have replied, in the terms of a previous extract (p. 36), that while the spirituous part escaped into the air, the grosser part was coagulated by cold and heat.

pino's statement. The passage occurs in a letter to Dr. Hofmann (Coll. ed., p. 635; Dr. Willis, p. 595), and is as follows: 'I do indeed assert that the blood is incessantly moving out from the heart by the arteries to the general system and returning from this by the veins back to the heart, and with such a flux and reflux in such mass and quantity that it must necessarily move in some way in a circuit.'

Now it is strange that Dr. Ceradini does not see the essential difference between these two passages.[1] Obviously the comparison with Euripus implies a flux and reflux through the same and not through different channels, while Harvey, in a few words, gives a clear description of the systemic circulation as a *constant* outflow (not during the waking state only) by the arteries, and a reflux by the veins, and in such quantity that it must necessarily move in a circuit. If Cesalpino had written this sentence, he might indeed have been credited with a knowledge of the

[1] In the Latin edition of Harvey, which Dr. Ceradini quotes, the words are: 'Eo fluxu et refluxu, *eâ quantitate et copiâ* ut in circuitu quodam modo moveri sit necesse.' In quoting this passage the four significant words here printed in italics are omitted. Was this in order to render Harvey's statement more like Cesalpino's than it would otherwise appear to be?

systemic circulation; but neither that nor anything like it is to be found in any part of his writings.

The passages in Cesalpino's works which show most conclusively that he could have had no idea of a continuous flow of blood from the systemic arteries to the veins, on its way back to the heart, are those which describe, or evidently imply, a passage of the blood *from the trunk to the branches* of the veins. Thus in the 'Ars Medica' (p. 488, ed. 1670) the following statement occurs: 'But the vena cava distributes branches throughout the whole body, in order that, together with the arteries, they may nourish every part. From the same vena cava some large branches, called emulgent veins, go to the kidney, by which (veins) the superfluous water of the blood is excreted, that it may be carried by the ureters to the bladder.'[1]

This passage requires no comment and admits but one interpretation. Neither does the following: 'As rivulets draw water from a fountain,

[1] 'Vena autem cava ramos in totum corpus dispergit ut simul cum arteriis universas partes nutriant. Ab eadem cava rami quidem insignes ad renes tendunt, venæ emulgentes vocatæ, per quas superflua sanguinis aquositas excernitur, ut per vasa urinaria in vesicam feratur.' The name 'venæ emulgentes' was doubtless suggested by the theory that those veins drain out the excess of water from the blood.

so do the veins and arteries draw blood from the heart.'[1] There is a parallel passage in the 'Ars Medica' (p. 1): 'The fountain of blood in the heart being distributed into four vessels—viz., the vena cava, the aorta, the pulmonary vein, and artery—irrigates the whole body like the four rivers proceeding from Paradise.'[2] Curiously enough, Dr. Ceradini quotes this passage in illustration of Cesalpino's clear view of the circulation (p. 294).

There is another remarkable passage in which it is clearly assumed that the blood under certain conditions passes by the veins of the neck upwards to the brain. In opposition to Galen, who taught that the nerves and nervous influence proceed from the brain and spinal cord, and in support of Aristotle's doctrine that the *heart* is the centre and source of all nervous influence, Cesalpino says no one denies the fact mentioned by Galen, that division or ligature of the spinal cord, or of a nerve, paralyses the parts below.

[1] 'Ut igitur rivuli ex fonte aquam hauriunt, sic venæ et arteriæ ex corde.'—*Quæst. Per.*, p. 116 *A*.

[2] 'Fons sanguinis in corde distributus in quatuor venas, scilicet cavam, aortam, arteriam venalem et venam arterialem, totum corpus irrigat instar quatuor fluminum ex Paradiso prodeuntium.'

But he goes on to argue that the same result follows the obstruction of all the vessels of the neck, because then the influence of the heart can no longer pass to the nerves. 'But it is not sufficient that the *arteries* of the neck alone be closed, which Galen sometimes found might be done without harm, for then a power is transmitted from the heart by the *veins* to the same parts, since there are inosculations between the veins and the arteries, not only in the heart, but along their whole course.'[1]

In the preceding passages we have conclusive evidence of Cesalpino's doctrine that in certain veins, and at certain times, the blood flows from the trunks to the branches, and Dr. Ceradini[2] himself admits Cesalpino's belief that during the waking condition of animals there is a reflux from the *aorta* into the left ventricle of the heart, in

[1] 'Non sufficit autem arterias solum, ut Galenus aliquando expertus est sine noxa in collo constringere, nam ex venis in eadem loca transfertur virtus a corde, cum osculorum sit communio non solum in corde sed etiam per totum venarum atque arteriarum ductum.'—*Quæst. Per.*, p. 121 *D.* In *Quæst. Med.* (p. 229 *F*) it is also stated that when the carotid arteries are obstructed the jugular veins, by means of anastomoses, carry on the blood to the brain.

[2] 'È vero del resto che negli animali vigili Cesalpino ammise un rigurgito dall' aorta verso il cuore' (p. 273.)

consequence of the difficulty with which the blood escapes from the terminal branches of the aorta to the nerves. Yet so determined is Dr. Ceradini to maintain his fellow-countryman in the position of the discoverer of the circulation that this theory of a reverse current from the aorta to the heart, which, if it occurred as a fact, would be instantaneously fatal, and which to an impartial critic affords conclusive proof of Cesalpino's ignorance of that which he is declared to have discovered, is held by his advocate not to be of the slightest consequence [1] (note *g*).

The most curious illustration of the manner in which Cesalpino's compatriots endeavour to obtain for him the credit of originality and completeness with regard to the circulation is afforded by a lecture by Dr. Del-Vita,[2] which is made up of extracts from all Cesalpino's writings, the original Latin and the Italian translation being placed in parallel columns; and the quotations from various treatises are so pieced together

[1] 'Ciò non pregiudica minimamente l'essenzialità della dottrina stessa della circolazione,' p. 269.

[2] 'Della Circolazione del Sangue Scoperta da Andrea Cesalpino, Lezione Anatomico-Fisiologica da Antonio Del Vita di Arezzo,' 1876.

as to read like a clear and continuous description of the circulation as we now understand it. The source of each word and sentence is given, and although the lecture occupies less than three pages of large type, so numerous are the references that all the letters of the alphabet are insufficient to indicate their source. The following brief paragraph is an illustration of the method adopted by this author:—'The blood, therefore, is carried from the right ventricle of the heart by the pulmonary artery, and again returned to the heart by the pulmonary vein, which proceeds from the left ventricle; from the heart it passes into the arteries, from the arteries to the veins, from the veins to the heart; so there is a perpetual movement from the vena cava through the heart and lungs to the aorta, and by the arteries into the whole body.' This description of the circulation, which occupies ten short lines, is not taken from any one part of Cesalpino's writings, but is extracted, as the letters of reference show, from six different parts of three separate treatises, namely: 'Quæstiones Peripateticæ,' 'Quæstiones Medicæ,' and the work 'De Plantis.' If Cesalpino had anywhere described the course of the blood, as it was

first revealed by Harvey, there would have been no need to resort to such a patchwork proceeding as this, which does no credit to its author, Dr. Del Vita, or to the orator, Dr. Maggiorani, who refers to the lecture with approval. It is manifest that by stringing together isolated words and sentences the doctrine of the circulation might be extracted from the Pentateuch or from any other ancient writings.

At the risk, and, I almost fear, at the cost of being tedious, I have made these numerous quotations from Cesalpino's various writings, in order to prove by his *ipsissima verba* what was the amount of his knowledge with regard to the systemic circulation.

I think that I have shown conclusively that great and various as were his acquirements in different departments of natural science, more especially in botany, in which science he had the merit of great originality, as regards the physiology of the circulation his information was not in advance of that possessed by his immediate predecessors and contemporaries. It will have been seen that Professor Ceradini relies mainly upon three distinct pieces of evidence to establish

his fellow-countryman's claim to be regarded as the discoverer of the circulation: (1) His use of the term 'circulation;' (2) his employment of the word 'capillamenta;' and (3) his observation of the effect of obstructing the current of blood in the veins. But a critical examination of each of these points has afforded evidence of Cesalpino's ignorance rather than of his knowledge of the circulation. (1) The term circulation, being applied only to the passage of the blood through the lungs, implies a want of knowledge of the systemic circulation; (2) the word 'capillamenta,' which is erroneously translated 'capillaries,' is used only to designate an imaginary transition from arteries and veins into nerves, the nerves and the capillamenta being declared to be impervious to blood; (3) and lastly, no intelligible explanation is given of the fact, which those who practise venesection had observed for centuries, that an obstructed vein swells on the distal side of the ligature or other obstructing cause.

To turn from Cesalpino's doubtful and contradictory utterances and his peripatetic fancies with regard to the circulation, to Harvey's clear

statements and exact reasoning, is like coming from a dark and stifling cave into fresh air and bright sunshine.

I propose, in conclusion, to give one extract from Harvey's treatise 'On the Motion of the Heart and Blood,' which affords a good example of his style, and which is especially interesting from its containing in a few sentences an illustration of the process of observation and reasoning which led up to his great discovery of the systemic circulation:[1]—

'When I surveyed my mass of evidence, whether derived from vivisections and my various reflections on them, or from the ventricles of the heart and the vessels that enter into and issue from them, the symmetry and size of these conduits—for nature, doing nothing in vain, would never have given them so large a relative size without a purpose—or from the arrangement and intimate structure of the valves in particular, and of the other parts of the heart in general, with many

[1] M. Flourens, in his *Histoire de la Découverte de la Circulation du Sang*, 1854, p. 30, says of Harvey's treatise: 'Le livre d'Harvey est un chef-d'œuvre. Ce petit livre de cent pages est le plus beau livre de physiologie.' For this favourable judgment of Harvey, however, the author is severely taken to task by Dr. Ceradini, pp. 206-7.

things besides, I frequently and seriously bethought me, and long revolved in my mind, what might be the quantity of blood which was transmitted, in how short a time its passage might be effected, and the like; and not finding it possible that this could be supplied by the juices of the ingested aliment, without the veins on the one hand becoming drained, and the arteries on the other getting ruptured through the excessive charge of blood, unless the blood should somehow find its way from the arteries into the veins and so return to the right side of the heart; I began to think whether there might not be A MOTION AS IT WERE IN A CIRCLE. Now this I afterwards found to be true; and I finally saw that the blood, forced by the action of the left ventricle into the arteries, was distributed to the body at large and its several parts, in the same manner as it is sent through the lungs, impelled by the right ventricle into the pulmonary artery; and that it then passed through the veins and along the vena cava, and so round to the left ventricle in the manner already indicated; which motion we may be allowed to call circular' (Coll. ed., p. 48; Dr. Willis, pp. 45–6).

It was the recognition and proof, by numerous observations and experiments, of the incessant propulsion of the blood by the contractions of the left ventricle of the heart through the systemic arteries into the veins, and so back to the right side of the heart, that constituted Harvey's grand discovery of the greater or systemic circulation.

Harvey, as we have seen, obtained his anatomical knowledge at Padua under the famous Fabricius, of whom he speaks with gratitude and reverence (Coll. ed., p. 65; Dr. Willis's trans., p. 62) as 'the celebrated Hieronymus Fabricius of Acquapendente, a most skilful anatomist and venerable old man.' While, therefore, we cannot concede to Cesalpino the honour of having discovered the circulation of the blood, a distinction which he himself would probably never have thought of claiming, we willingly express our gratitude to Italy for having given our celebrated countryman the anatomical training without which he could not have made his great discovery —a discovery which, throughout all ages and by all civilised nations, will be looked upon as the foundation of modern physiology, and therefore of scientific medicine.

# NOTES.

## NOTE *a*, page 23.

Harvey demonstrated the passage of blood through the lungs and the impermeability of the septum cordis by an experiment which he thus describes in one of his letters to Schlegel:—

'Having tied the pulmonary artery, the pulmonary veins, and the aorta in the body of a man who had been hanged, and then opened the left ventricle of the heart, we passed a tube through the vena cava into the right ventricle of the heart, and having at the same time attached an ox's bladder to the tube we filled it nearly full of warm water, and forcibly injected the fluid into the heart, so that a greater part of a pound of fluid was injected into the right auricle and ventricle. The result was that the right ventricle and auricle were enormously distended, but not a drop of water or of blood made its escape through the orifice in the left ventricle. The ligatures having been undone, the same tube was passed into the pulmonary artery, and a tight ligature having been put round it to prevent any reflux into the right ventricle, the water in the bladder was now pushed towards the lungs, upon which a torrent of the

fluid, mixed with a quantity of blood, immediately gushed forth from the perforation in the left ventricle, so that a quantity of water, equal to that which was passed from the bladder into the lungs at each effort, instantly escaped by the perforation mentioned.' (Dr. Willis's trans.,[1] p. 597; Coll. ed., 613–4.) Dr. Ceradini (p. 194) is so good as to express his admiration of this experiment having been performed by Harvey at the advanced age of seventy-three years.

NOTE *b*, page 25.

Dr. Ceradini endeavours to prove that Cesalpino's use of the word *circulation* implied his recognition of the systemic as well as of the pulmonary circulation by first quoting Aristotle's definition of the word:—'Conversio est motus qui fit ex sese in idem' (Circulation is motion from itself into itself). 'Motus autem per rectum qui ab sese in aliud' (but straight motion is that from itself into another).[2]

And then he quotes a metaphysical discussion of Cesalpino's, having no reference to the movement of the blood, but in which the celestial circulation is compared with the divine intelligence:—'Circulatio autem tanquam fine carens infinito tempore agitur' (the celestial circulation, as if without end, goes on perpetually). And again, 'quatenus autem continua motione ab eodem in idem transit (idem enim est circuli principium, medium

[1] The references to Dr. Willis's translation are to the Sydenham Society's edition of the works of Harvey, translated by Robert Willis, M.D., 1847.

[2] Ceradini, p. 253. Cesalpino, *Quæst. Per.* p. 33 *A*.

et finis) maxime assimilatur intellectioni quæ est sui ipsius.' Since by a perpetual motion there is a passage from the same to the same (for the beginning, the middle, and the end of a circle is the same), there is the greatest resemblance to the (divine) intelligence, which is self-originating.

Dr. Ceradini maintains that Cesalpino having thus accepted Aristotle's definition of a circular movement, could never have intended his use of the word to be limited to the passage of blood from the right to the left side of the heart through the lungs, but he must have meant to express the idea of a general circulation throughout the system.

It will be seen, however, that Cesalpino's views of the systematic circulation are utterly inconsistent with his modern interpreter's argument.

NOTE *c*, page 27.

It is manifest that without the aid of the microscope the mode in which the blood passes from the arteries to the veins could only be a subject for speculation. Harvey in his original treatise speaks of 'pores in the flesh' (*porositates carnis*), through which he supposed the blood to pass (see Coll. ed., p. 69; Dr. Willis, p. 68); but in his letter to Schlegel (Coll. ed., p. 627; Dr. Willis's trans., p. 600), after expressing his opinion that the passage of the blood from the extremities of the arteries into those of the veins could not be effected without some 'admirable artifice,' suggests that the minute arteries may gradually pass into the coats of the accompanying veins, and 'that

the same thing took place here as we observe in the conjunction between the ureters and the bladder, and of the biliary duct with the duodenum.' Malpighi was the first who with the aid of lenses had the delight of seeing the blood actually circulating through the capillaries in the lung and mesentery of the living frog. (Marcelli Malpighi, 'Opera,' Lond. 1687, pp. 141–2; and 'Opera Postuma,' Amsterdam, 1700, p. 122.) Malpighi speaks of the appearances as beyond the power of his pen to describe ('qui calami subterfugiunt descriptionem'), and we can imagine with what delight Harvey would have witnessed the circulation in the magnified web of a frog's foot.

NOTE *d*, page 34.

Dr. Ceradini (pp. 67 and 286) refers to an observation of Hippocrates ('De Natura Hominis,' sect. iii. p. 6), that when an artery is wounded the blood which first flows is of a brighter red colour than the dark blood which subsequently escapes; also to Galen's statement that a wound of an artery empties not only the arteries but the veins, the result, as Galen supposed, of the anastomosis between the arteries and the veins throughout the body.

Reference is also made to Cesalpino's statement ('Quæst. Medicarum,' p. 212c), that 'the veins are so connected with the arteries by little mouths, that when a vein is wounded dark venous blood first escapes, then succeeds lighter coloured arterial blood.' ('Venas cum arteriis adeo copulari osculis, ut vena secta primum

exeat sanguis venalis nigrior, deinde succedat arterialis flavior.') Dr. Ceradini remarks that this observation of Cesalpino, together with that of the veins swelling beyond a ligature, affords proof of the circulation as complete as it is possible to furnish.

What the quotation really appears to prove is, that Cesalpino, in common with Galen, believed that the veins were everywhere connected with the arteries by inosculations; and as the observations of Hippocrates and Galen seemed to prove the passage of blood from veins to arteries, his own doubtful observation on the effect of venesection appeared to him to prove the passage from arteries to veins, not, be it observed, by capillaries, but by inosculations.

Harvey was the first to prove the absence of the supposed anastomoses between the veins and the arteries by an experiment which he thus describes in his 'Anatomical Disquisition,' addressed to John Riolan:[1]—

'Having laid open the thorax of an animal, and tied the vena cava near the heart, so that nothing shall pass from that vessel into its cavities, and immediately afterwards having divided the carotid arteries on both sides, the jugular veins being left untouched, if the arteries be now perceived to become empty, but not the veins, I think it will be manifest that the blood does nowhere pass from the veins into the arteries, except through the ventricles of the heart. Were it not so, as observed by Galen, we should see the veins as well as

[1] Coll. edition, p. 106; Dr. Willis's translation, p. 104.

the arteries emptied in a very short time by the efflux from their corresponding arteries.'

NOTE *e*, page 36.

Prof. Ceradini maintains that Cesalpino meant by *auctive* blood in this passage, blood which had passed through the organs and is returning towards the heart to augment the blood which is there being constantly fabricated, and he accuses Harvey's biographer, in the College edition of his works (p. xx.), of having with bad faith inverted the sense of the passage (pp. 244–5). But it clearly admits of no other interpretation. For as, in accordance with Aristotle's doctrine, Cesalpino believed that the veins contained the auctive blood, while the nutrient blood is in the arteries ('Quæst. Per.' 117 *E*), it is evident that the arteries could 'elicit' auctive blood from the veins through the anastomoses, only by a direct current from the veins into the arteries. Cesalpino, in his entire ignorance of the hydraulics of the circulation, could not know that if there were such anastomoses as he supposed between the veins and the arteries, the current of blood must of necessity, in consequence of the greater pressure in the arteries, set from them to the veins—as in a case of aneurism by anastomosis.

NOTE *f*, page 42.

Dr. Ceradini refers to Cesalpino's statement that *all* the veins swell when obstructed, as conclusive proof that he had actually seen the effect of obstructing all

the veins either while witnessing operations on the human body or as a result of the vivisection of animals, which he assumes that he must have practised by the necessary aid of artificial respiration, which Vesalius may have taught him to practise (p. 265). Thus while almost ignoring Harvey's numerous experiments, and asserting that the presence of valves in the veins was the only evidence adduced by him in proof of the systemic circulations, he gives Cesalpino the credit of having performed experiments of which no mention whatever is made in that author's writings. In fact, Cesalpino mentions no experiments or observations of his own, but refers only to a fact known, as he says, by those who practise venesection.

NOTE *g*, page 48.

It is not without interest to contrast Dr. Ceradini's severe and sometimes unjust and erroneous criticism of Harvey with his very lenient judgment of Cesalpino's errors.

Thus we have seen that Cesalpino's admission of a reflux of blood from the aorta to the heart during the state of wakefulness is looked upon as a pardonable error, but, on the other hand, the slight inaccuracy (an inaccuracy which can be shown to be such only by the aid of modern instruments) implied in Harvey's statement that the arterial pulse is felt simultaneously over the whole body is severely criticised (p. 185).

Again, while he censures Harvey for neglecting to

mention Cesalpino's name and writings, the latter's omission to quote his fellow-countryman Colombo in reference to the pulmonary circulation and the impermeability of the septum is excused, amongst other reasons for this, that 'Colombo's zeal, and the energy with which he maintained the impermeability of the septum cordis, without furnishing any new anatomical or physiological proof, appeared to Cesalpino to be rather comical than otherwise' (pp. 256–7). It does not appear to have occurred to the learned Professor that Harvey may have thought that Cesalpino's speculations on the outward flow of the blood during the waking state, and its reflux during sleep, had more of the ludicrous than the luminous about them; and that, if Harvey had wished to exalt himself by comparison with others, he could not have done this better than by printing in parallel columns his own brief and clear description of the circulation, and the fanciful theories of Cesalpino.

Both Professors Ceradini (p. 298) and Scalzi (p. 19) contrast what they designate Cesalpino's gentleness and modesty with Harvey's vehemence and pomp of words ('violenza e pompa di parole'). And this Dr. Ceradini considers a sufficient explanation of the little notice taken of Cesalpino's physiological writings, while Harvey found himself at once assailed by a host of enemies. The simple explanation of this contrast is that one was nothing more in physiology than an expounder of ancient speculations, which being for the most part unintelligible, excited no controversy, while the other set forth

novel doctrines with such unmistakable clearness as to excite at once the attention of the world and the opposition of all to whom previously unrecognised truths are unwelcome, and even hateful.

Dr. Ceradini asserts that Harvey's doctrine of the blood being propelled into the ventricle by the contraction of the auricle is erroneous; and this notwithstanding the decisive evidence[1] which Harvey adduces in support of his statement (Cer. p. 87). Dr. Ceradini expresses his determination to enter upon an experimental inquiry with regard to this question. In the course of this inquiry he will do well to take into consideration the evidence in support of Harvey's doctrine of the propulsive influence of the auricles, which is afforded by the clinical phenomena of the presystolic (auriculo-systolic) thrill and murmur which result from constriction of the mitral orifice.

Dr. Ceradini not only exaggerates greatly the importance which Harvey attaches to the valves in the veins as evidence of the course of the blood, but, in order, as it would seem, to depreciate as much as possible what he most inaccurately asserts to be the only

[1] 'After the heart (*i.e.* the ventricles) had ceased to beat, the auricles, however, still contracting, a finger placed upon the ventricles perceives the several pulsations of the auricles, precisely in the same way and for the same reason, as we have said, that the pulses of the ventricles are felt in the arteries, to wit, the distension produced by the jet of blood. And if at this time, the auricles alone pulsating, the point of the heart be cut off with a pair of scissors, you will perceive the blood flowing out upon each contraction of the auricles.'—Dr. Willis's Translation, p. 27. Coll. Edition, p. 29.

new evidence which Harvey could adduce in proof of the circulation, he maintains that the valves in the veins are not at all necessary for the circulation of the blood ('Le valvole delle vene non sono punto necessarie alla circolazione del sangue,' p. 202). Perhaps it has not happened to the learned Professor of Physiology to witness the many distressing and even fatal consequences of the impeded circulation that result from such a dilated and varicose condition of the veins as renders their valves incompetent to prevent the reflux and backward gravitation of the blood.

The best piece of criticism in Dr. Ceradini's book is that to be found at the commencement of the first chapter, in which, after referring to a tablet in the Veterinary Institute of the University of Bologna, attributing to Carlo Ruini the discovery of the circulation of the blood, he mercilessly exposes the plagiarisms of Ruini and demonstrates the utter absurdity of the attempt to make of him a great discoverer. At the end of the chapter (p. 74) he expresses a hope, in which he believes that every friend of truth and justice will join, that the lying inscription (l'epigrafe menzognera) which speaks of Ruini as the discoverer of the circulation may be removed from the walls of the University of Bologna. It is somewhat embarrassing for zealous patriots that Italy should simultaneously have monuments in honour of two supposed discoverers of the circulation—that of Cesalpino at Rome, and that of Ruini at Bologna.

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